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REPORT
CD NO.

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COUNTRY	USSR	DATE OF INFORMATION	1949
SUBJECT	Scientific - Engineering, interferometry chemistry, gas analysis		
HOW PUBLISHED	Monthly periodical	DATE DIST.	16 Apr 1952
WHERE PUBLISHED	Moscow	NO. OF PAGES	3
DATE PUBLISHED	Nov 1949		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

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SOURCE Zavodskaya Laboratoriya, Vol XX, No 11, 1949, pp 1383-1384.

INTERFEROMETRIC METHOD FOR DETERMINING NITROGEN AND ARGON IN A GAS MIXTURE

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The analytical determination of nitrogen and argon by chemical means is quite complex when both are present in a mixture of gases.

To solve this problem, we used an interferometric method, employing a portable interferometer (Figure 1) /not reproduced; available in the original document in OIA/, distinguished from the laboratory type by its compactness and its airtight optical parts.

The parts of the instrument are: illuminating device (B); eyepiece (OK); measuring cylinder (M); microcamera (MK); rheostat (R); and the protective cover (K).

The light source (Figure 2) /appended/ is situated next to the eyepiece (OK), and consists of a small incandescent lamp and a lens system which focuses the lamp filament on a slot. The light emerging from the slot falls on the mirror (S) at the opposite end of the instrument. In front of the mirror are two double diaphragms which separate the light beam into two narrow parallel beams producing the interference spectrum. The beams reflected by the mirror are brought together again by an object lens. The interference image is viewed sharply by means of the magnifying eyepiece.

When using the compensator scale to determine the degree of displacement, it is necessary to figure accurately the value of one band over the entire scale in definite intervals.

Since each interferometer has its own characteristics, the graduating is always done by the same researcher.

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After graduation by monochromatic light, it is expedient to calculate the differences in refraction indexes corresponding to readings of 100, 200, etc. on the cylinder and to note these results on a table.

If m bands correspond to 100 divisions of the scale, then the value of one division is

$$K = \frac{\beta_2 - \beta_1}{100} = \frac{m\lambda}{100\alpha}$$

where m is the number of bands on a section of 100 graduations; λ is the light-wave length; α is the length of the vessel; and β_1 and β_2 are the indexes of refraction of the gases under comparison.

In our case, calibration was made in sodium light ($\lambda = 5893 \cdot 10^{-8}$ cm) using a portable interferometer with a 50-cm long chamber. In the case of autocollimation, when the light beam traverses the vessel twice, the length must be doubled.

If we designate the difference in readings for the tested argon and pure nitrogen (number of divisions on the calibrating-screw cylinder) as $N_2 - N_1$, then $(N_2 - N_1) \cdot k = \beta_2 - \beta_1$. Thus, for normal conditions we have

$$X = \frac{100\,(N_2 - N_1)\,k}{\beta_2 - \beta_1}$$

where x is the argon content in percent by volume. The percent-by-volume content of nitrogen will then be 100 - x.

If the pressure of the tested gas and of the pure comparison gas is P, and the temperature is t, then

$$X = \frac{100\,(N_2 - N_1)\,K}{\beta_2 - \beta_1} \cdot \frac{760\,(1 + \alpha t)}{P} \qquad (1)$$

The value of $\beta_2 - \beta_1$ during analysis of the argon-nitrogen mixture is taken as $16 \cdot 10^{-6}$.

Industrially-produced argon has certain admixtures (see table below).

With the zero setting checked, the right chamber of the vessel is filled with the gas being studied. The gas must first have been purified of carbon dioxide, oxygen, and moisture. It is necessary to cool the gas before it is put into the chamber if the mixture being studied is subjected to heating; i.e., oxygen elimination is accomplished by means of incandescent copper.

Content of Admixtures in Argon (in %)

Components	Technical Argon	Purified Argon
Nitrogen	18	>2
Carbon dioxide	0.2	
Oxygen	0.5-1.0	0.5-1.0
Water	0.5	

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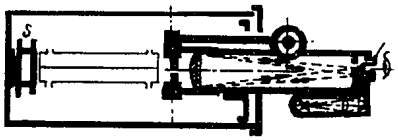
A thermometer and mercury manometer are included in the system for control. The left chamber of the interferometer vessel is filled with the comparison gas, nitrogen, which has first been purified. After the chambers are filled, a reading is taken using the cylinder of the compensator, for which the interferometer image corresponding to the coincidence of zero-period maximums is reduced. The zero setting then is disrupted and reset several times and, if the readings coincide, it is fixed. The content of argon and nitrogen in the mixture is calculated after substituting in equation (1) the data obtained.

/Appended figure follows./

Figure 2. Light Source



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